

General Statement:

Certain recent technical developments are now ripe for exploitation to the advantage of the photo interpreter. Two of the developments are emergence of the Laser as a dependable, productive instrument; and application of the Fourier Transform to photographic spatial frequencies resulting in the powerful Contrast Transfer Function Concept. These new tools make it possible to significantly upgrade the support of a photo interpreter's capability.

In applying these tools to new support equipment, it is important to introduce the concepts of the psychologist in combination with the concepts of the engineer to insure that the new equipment will be a truly responsive servant of the interpreter and function to enhance his effectiveness and not fetter it.

Attached are some ideas which are proposed as a nucleus for investigation into a new support program:

1. The next generation of Interpreter Viewers.
2. The Corporate Technique of Management by Exception.
3. Edge Measurement.
4. Image Quality Feedback.
5. Tracking and Plotting.

STATINTL

June 22, 1963

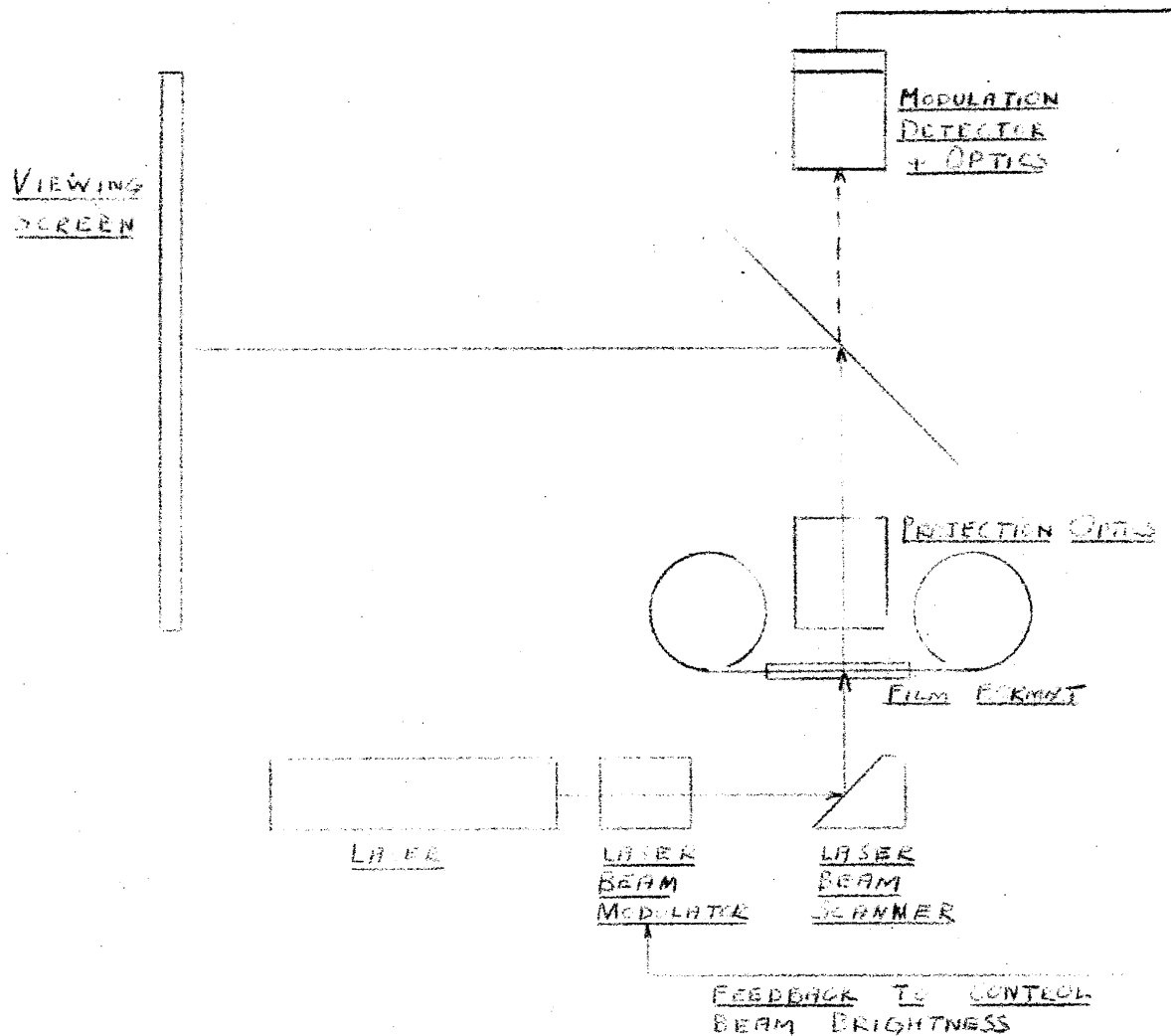
1. The next generation of Interpreter Viewers

The Laser offers the possibility of a significant breakthrough in projection viewers for the photo interpreter. An analytical and experimental investigation is required to confirm its potential.

The Laser produces an intensely bright light beam of a single color. The beam is a few millimeters in diameter, highly collimated and is effectively a point source at infinity. The recent scientific achievements in manipulation of the Laser beam provide the needed versatility for a new dimension of control to be exploited.

An experimental setup is proposed in which the Laser beam would be played across the film format being viewed much as an electron beam is scanned across a TV tube. Similar framing rates would be used to present a continuous picture of the whole format to the interpreter. The high intensity of the beam would penetrate even the deepest shadows. At the same time, automatic control of the beam brightness would prevent dazzling the observer when the beam passes through a highlight area of low density. Thus, a degree of automatic dodging can be achieved. A schematic arrangement of the experimental setup is shown attached. The investigation will be principally concerned with the psychological effect of automatic dodging on the interpreter and the possible extension into image enhancement.

A Schematic Arrangement of an Experimental Laser Set-up



June 22, 1963

## 2. The Corporate Technique of Management by Exception

It appears possible that an effective technique can be borrowed from industry and applied to photo interpretation. The purpose is to provide certain and absolute information to the small group of men who must report to the President regarding the threat potential of given areas.

The technique is this: When a Norm is established or known, then only exceptions to the Norm require specific evaluation. As applied to photo interpretation, a given area has a normal rhythm of activity which a photo interpreter will sense with suitable study. So long as this Norm persists, the threat from this area will be zero and the threat potential an established value. For this condition only the photo interpreter need be concerned with study of the area. A disturbance in normal activity will give very early warning of the build up of a threat. Since the total observation and reasoning capacity of the interpreter is used, it would be virtually impossible for him not to detect a disturbance. The disturbance is the exception referred to above, which is to be evaluated and managed by a higher echelon. It is this early warning which provides time for evaluation, for obtaining additional coverage and for detail analyses necessary to form an error-free judgment for presentation.

The technique is principally applicable to the study of peripheral areas and does not affect the normal target analysis activity. In fact, present activity uses many of the elements of the technique already. A formal study will serve to define the favorable and the unfavorable aspects of the procedure. It will go far towards determining how an interpreter projects himself into an area, what helps him to grasp the normal activity pattern and what hinders him.

Additionally, data will be compiled regarding how large an area an interpreter can be expected to assimilate and how much overlapping of areas is necessary to provide adequate redundancy of coverage. This data will be usefull in determining the interpreter force levels required to implement the concept.

### 5. Edge Measurement

Application of the Contrast Transfer Function Concept may permit measurements on a photograph to a precision considerably finer than the actual resolution. The concept is simple. A knowledge of the Contrast Transfer Function of the taking camera permits reconstruction of a sharp edge from its image. The location of that edge with respect to its image then becomes a known quantity and can be used to determine the precise location of the desired edge within an image being measured. An analytical and experimental study is required to determine how to measure the Contrast Transfer Function from the take on hand. The study will also produce a method of scanning the image of the edge under measurement and a method of correcting to actual edge location within the image scanned.

#### 4. Image Quality Feedback

The exploitation operation is in a command position relative to the output quality of the collection operation. This is a proper relation since exploitation is the customer of collection and provides the only place where continuous evaluation of the output can be accomplished. Such evaluation is extremely important to the maintenance and improvement of image quality by collection, and feedback of information to them is as important as any other aspect of the operation.

The feedback should first be immediate so that corrections can be made before the next operation. Secondly, the feedback should include an objective numerical determination of image quality presented in terms well understood by collection and related to the Contrast Transfer Function of their system. It appears that some powerful physical concepts can be utilized to provide such information. A statistical analysis of the spatial frequency content of a photograph can be related to image quality.

The procedure is as follows: A random scan of a frame by a microdensitometer type of instrument is produced. The autocorrelation function of the microdensitometer signal is computed to reveal the spatial frequencies. Since a statistical approach is being used,

the relative weight of the spatial frequencies must be determined by computing the power spectrum. The power spectrum (which is the Fourier Transform of the auto-correlation function) is a representation of the Contrast Transfer Function of the photograph. The appearance or non-appearance of certain frequencies can be related to various aspects of camera system performance.

A study will be required to set up the analytical equations and determine the computer program. In addition, experimental microdensitometer traces will be required to be made as part of the study. The traces will permit testing the hypothesis and proving out the equations and the computer program. The ultimate aim of the study will be to define a clear technical path for development of an instrument which will automatically measure image quality of received material.



June 22, 1963

## 5. Tracking and Plotting

A strip map of the mission ground track is important collateral to the photo interpreter. Although such a statement is obviously true, achievement is often difficult. Ideally, the strip map should be specific to the mission. It should be annotated with frame numbers and have oblique coverage blocked out. Most important, it should be available to the interpreter when he first receives the film for scanning and in a form convenient for him to use.

To define a development program to achieve such a goal requires a study of the tracking and plotting function. It does not seem feasible to reach the goal by brute force manpower with conventional methods of plotting, filing and sorting. Labor saving devices and the automating of some functions are needed. An independent formal study will serve to define the specialized adaptation of automatic map storage and retrieval equipment and the rapid reproduction of conventional maps into mission strip maps. The study will also sift annotation data to determine what should be imprinted on the maps.